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Dynamic Service Product Family for Mass Service Customization

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Abstract: Service business today plays a significant role in the global economy. It aims to provide value for customers and ultimately related to customization in its nature. Although a variety of services are offered to customers, there still lack systematic ways to provide service customization efficiently. This paper aims to customize services efficiently to satisfy various customer needs. Particularly, we wish to achieve economies of scale, economies of scope with capability of manage the complexity of demands. In this paper, we develop a service product family structure for service customization by extending the idea of product family in product design. The hierarchically functional representation forms the basis of service product family. In the meantime, the service product family can also be extended to dynamic service product family to manage service changes over time via process mining technique. A case study of hotel service management is introduced to illustrate the proposed approach.

Keywords: service management, service design, service product family, mass customization, process mining, quality of services

Ⅰ. INTRODUCTION

Modern service industry plays an increasingly significant role in world economy. It has witnessed the worldwide burst of different kinds of services which influenced human's life in the past decade. It has been reported that service accounts for more than 50 percent of the labor force in developed countries, for example, 80 percent for the United States and the Japan and 70 percent for European Union [38]. Hence, the focus of world economy is gradually changing from manufacturing to service.

Services aim to provide value for customers and thus it is ultimately related to customization in its nature. In addition, a service is a time-perishable and intangible experience performed for a customer who acts in the role of co-producer [1]. In the current customer-centric marketplace, customers are more empowered and demanding. They require personalized service with high service level while at the same time with relatively low cost. Therefore, in these competitive service industries, with the emerging of new technologies and the transparence of information, a firm's competitiveness relies on service innovation, customization and quality provision to a large extent.

Successful services are achieved by dynamic organizations that can adapt changes in a short time and has capability to provide high quality of them. How well a service can adapt depends greatly on the flexibility that organization and process flows have been designed into it. Basically, a service is enabled by a service process which is a set of ordered activities performed by human agents with the support of necessary input and providing identifiable service output for external customers [37]. The outcome of service can also vary due to the distinct responsiveness, empathy and assurance of service providers. However, it has been acknowledged that a good design of the process entails excellent service and facilitates service operation management in different aspects. It facilitates quality control as well as resource utilization; consequently, it reduces the cost of company and further feedbacks to the customer and gains more satisfaction.

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Service by nature is customized. Different service contents lead to different structures of organization deployment and successively different process sequences. Although a variety of services can be offered to customers, there still lack efficient ways for service process design, particularly service customization. Most existing practices try to please customers in an *ad hoc* manner which is difficult to generalize to other service applications and difficult to maintain the quality. These approaches are expensive and less efficient and cannot hardly sustain in the long run.

The objective of this paper is to develop a systematic approach to provide service customization efficiently. Particularly, we wish to achieve economies of scale, economies of scope, and thereafter manage the complexity of matching service capacity and demand efficiently. Service experience comes from the satisfaction of service content, process, structure and outcome. Service process can be viewed as the product consisting of deeds, processes, and performances [26]. In order to achieve service quality and productivity, service process has to be designed properly. In manufacturing industry, similar situations also exist for product design practice. Mass customization, a technologies aiming at satisfying individual customer needs with near mass production efficiency [3], has been applied quite well to handle the seemingly contradictive object of achieving both customer satisfaction and efficiency. This paper will extend the methodologies in mass customization, particularly product family to the service customization. However, mass customization is product-oriented and differs from service-oriented market. The methodologies for mass customization focus on product varieties and its assembling or manufacturing processes. Service market is “prompt customized” requiring immediate process change from service content varieties with little time relay allowed. In the other respect, to guarantee less waiting time, resource arrangement becomes a dominating issue in service market. Therefore, it is urgent and necessary to facilitate processes design and illustration for execution and to manage varieties changing with time. To tackle the issues, service product family (SPF) is proposed to manage service varieties and related processes in a single context. With service product families, different service varieties can be identified and categorized to form the bases of customization. We identify commonalities which characterizes different services. The commonalities play a critical role of production enhancement and serve as pillars of service customization.

Another technique adopted in this paper is process mining. It identifies real process model from observed system behavior and offers unknown process structures after execution. These discovered adaptive process models and modules allow us to distinguish the varieties of service provided in real world. In the consequence, continuous process changes and improvement can be easily controlled and implemented through design cycles of dynamic service product family (DSPF). The rest of the paper is organized as follows: section Ⅱ reviews some methodologies used in mass customization, business process modeling and management and process mining; section Ⅲ describes the service product family architecture; Concept of dynamic service product family is presented in section Ⅳ; section illustrates an example of the dynamic service product family; section Ⅵ concludes the paper.

Ⅱ. RELATED WORK

The basic characteristics of service have been identified in previous section. In this part, we will briefly review related literatures from methodology perspective. Basically we investigate three pillars of achieving service customization, mass customization and product variety, business process modeling and management, and process mining.

A. Mass customization and Product Variety

Mass customization aims at satisfying individual customer needs with mass production’s efficiency. It has attracted much attention from both academia and industry and has been considered as a viable strategy for companies to gain competitive advantage [32][33]. Among all of its enablers, product family has been well recognized as a rationale of achieving mass customization. Product family offers a systematic diagram which defines product platform, product architecture, product family, product family architecture and variety design and fulfillment. Product platform is “a set of subsystems and interfaces developed to form a common structure from which a stream of derivative products can be efficiently developed and produced” [11]. Product architecture is mainly concerned with how a product is arranged into physical units and how these units interact [12]. Tseng and Jiao recognized the rationale of a product family architecture (PFA) with respect to design for mass customization. They addressed an efficient method to tailor different products according to different customers’ requirements based on common product family platform. They also observed the difference between customer-perceived variety in terms of functionality and technical variety, which

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results in different variety design themes [15].

There are two types of prevailing product family design, scalable product family design and configurational product family design [36]. Simpson first proposed the scalable approach by using scaling variables to in different dimensions to satisfy a variety of customer needs [34]. There are two major tasks in scalable product family design. The first one is to determine the appropriate platform. It is followed by the step of optimizing common and distinctive variables values to better satisfy performance and economics requirements. The other stream of research in product family design is configurational product family design based on modular product architectures. Thus it is also called module-based product family design. It depends largely on the standardization of product family. The design of product can be enabled by configuring from existing choices of each component. It allows the functional elements of the product to be modified by changing the corresponding components which greatly facilitates the product family design process [35].

B. *Business process modeling and management*

Business process is the combination of a set of activities within an enterprise with a structure describing their logical order and dependence with the objective of producing a desired result [17]. The study on business process focuses on two topics, business process modeling and business process management. Business process modeling enables a common understanding and analysis of a business process. The concern of business process management is to support the task of design, enacting, control and analysis of operational process involving humans, organizations, applications, documents and other sources of information [18]. The life cycle of business process management can be decomposed into process design, system configuration, process enactment, and diagnosis [19]. Despite that the form of service is different from real product, there still exists some similar characteristics between two.

There are several modeling techniques and languages which describe different perspectives of business processes. Toussaint et al. find three essential aspects of processes, which are functional, static, and dynamic [39]. Phalp et al. distinguish between two uses of business process models: one for traditional software development and the other for restructure business processes [40]. They also argue that pragmatic approaches are mostly concerned with capturing and understanding processes, while rigorous paradigms are typically used for analysis of processes [41]. Macintosh defines five levels of process maturity [42]. The first three describe the process and knowledge of the processes to be captured and analyzed; level 4-5 require decision support in order to monitor and control processes. Macintosh's model permits representation of activities including time, resources, causality and authority. Workman et al. presented the historical development of enterprise organization and information technology distinguishing six phases [43]. They explain the main descriptive aspects and argue that different models are needed for each phase. Hommes et al. gave "the way of modeling" which identifies four elements of any individual model: notation, meaning, concept relationship and modeling concept [46]. Phalp used a similar idea which underlines that notation and method are two important considerations when modeling business processes. Both method and notation will depend on the desired purposes. In the other respects, business process can be described at different levels of detail depending on the different level of abstractions which depends on the purpose of analysis.

C. *Process mining*

Today's information systems are driven by explicit process models. However, there are discrepancies between actual processes and the processes perceived by management level. To solve this issue, process mining is applied to extract information about processes from the record of actual process, transaction logs. There are several algorithms trying to build the process models from event logs.

The earliest α algorithm create four types of relationships between two event tasks [20][21]. Because α algorithm assumes all the event logs are complete and without noise, it cannot handle real logs and cannot deal with loops. HeuristicMiner algorithm constructs dependency and frequency table to refine the relationships between two event tasks [22]. It successfully confronts logs with incomplete cases and noise. A technique that preprocesses raw traces in order to obtain significantly better process mining results is proposed, called trace clustering [23]. This technique group similar data in clusters based on a distance metric and divide logs into more homogeneous subsets that leads process mining results more structured. Activity mining [24] focuses on deriving the relative global correlation between event classes and then does trace segmentation. It builds event class cluster hierarchy and results in less

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complex process models. Another trace clustering method based on conserved patterns adopts pattern definitions to capture manifestations of commonly used process model and provide a means to form abstractions over these patterns [25]. Process mining currently has been noticed as a trend within business intelligent and business process management. In this paper, we adopt fuzzy mining of process mining technique to discover the variety within a service product family.

Ⅲ. DESIGN OF SERVICE PRODUCT FAMILY ARCHITECTURE

A. Adopt product family to service product family

Product family aims to "provide a set of subsystems and interfaces to form a common structure from which a stream of derivative products can be efficiently developed and produced". The most different portions of traditional product market with service market are that service is more promptly changed and highly fluctuated; service involved more complicated process because of runtime demands due to varieties; service can be seen as a product produced by customers and service providers where resources limitation due to immediately customer waiting. Therefore, in this paper, we take the advantages of product family and adapt the product family to service product family to tackle the issue of service customization.

With these different characteristics, service product family and product family has been design differently by following attributes:

	Product Family	Dynamic Service Product Family
Scope Difference	Tangible product	Intangible service
Scale Difference	Product commonalities and varieties, configure associated product structure and assembly process	Service and service process commonalities and varieties versus time, associated service features and process with resource allocation
Methodology Difference	Common platform identification	Process mining, Process modeling, version control, SPF merging

Table 1 Difference of product family and service product family

B. Design of service product family

The spirit of product family comes from leveraging modularity and commonality. With modularity and commonality, varieties can be distinguished to form different families. Service product family (SPF) adopts product family structure and inherits these features. The contents of those modules in the SPF offer the choice dimension to the customers and definitely are the targets of service under commitment. Base on this structure, we can identify service modules/ contents and varieties distinctly. In the other respect, to tackle prompt demands, runtime varieties, and required optimized resource to provide better service and quality, we include service process model into service product family. The differentiation of product family components and process model is the modules which are executed by service provider or by service provider and customer both, and not the choices but required procedures for completing the services. The modules of product family definitely should be included in the process model as a procedure to be executed because that is the target contents of service itself.

For fulfill mass service customization, we identify three generic pillars of SPF.

(1) SPF structure: As explained above, SPF consists two parts, namely the service configuration engine which adopts from product family and the process model. Modular based process model enables the possibility of resource dispatching and toward the goal of achieving service customization by near mass production efficiency. From the design of product family [2], all service product variants of a family share a common structure E_i's at top abstraction level, where E_i's are customer target wanted. Each E_i can be further decomposed into a series attributes with one main objective for each attribute. Different sets of E_i's distinguish different common service structures and thus represent different service product families. For achieving the target services, there might be some

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procedures required to fulfill which are not choices of services themselves where we denoted them as C_i in the process model. Only E_i's will be represented in the configuration engine and both E_i's and C_i's complete the process model.

(2) Variety parameters: Usually, there is a set of attributes $\{A_i\}$ associated with each E_i. Among the A_i's, some variables are relevant to variety, and thus are defined as variety parameter, p_i. Each p_i belongs to certain attribute A_j. Different instances of a particular A_i embody variants $\{v_k\}$, another type of varieties coming from the sequence flexibility particular in services. In the generic view, the sequence variety can be demonstrated without any confusion as S_{i_j}. For example, S_{12_13} indicates E_{12} is executed before E_{13}; and S_{13_12} represents E_{12} is executed after E_{13} .

(3) Configuration constraints: Three types of constraints can be identified in a SPF. Within a particular SPF view, restrictions on the combination of $\{V_k\}$, are categorized as Type I constraint, also called XOR constraint. It means two values $V_{11\_1\_1}$ and $V_{13\_2\_2}$ are incompatible and only one of them can be selected for a service variant. Matching relationships of modules and their variety parameters of SPF are referred to as Type II constraints, also called include constraint. It means two variety parameters must exist together. This type of constraint comprises mostly configuration design knowledge. Type III constraint describes the restricted sequence of modules. It is also called sequence constraint. An example of the three types of constraints is illustrated in Table 2.

	Type of constraint	Example
Type I	XOR constraint	If choose A11, you cannot choose A12.
Type II	Include constraint	If choose A11, you need to choose B11.
Type III	Sequence constraint	E2 should be executed after E1.

Table 2 Three types of constraints of SPF

C. Prototype of service product family

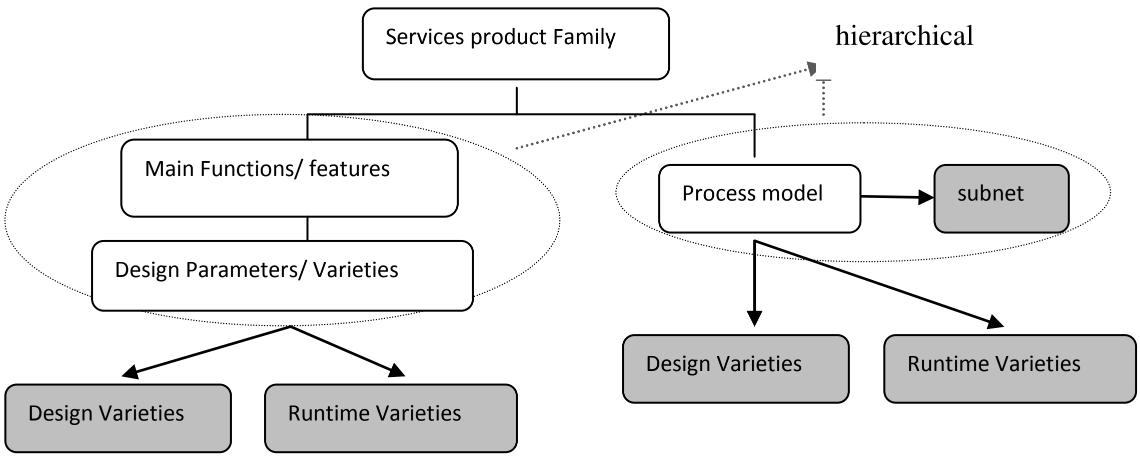

Figure 1 Prototype of SPF

A prototype of SPF is designed based on the approach of section Ⅲ(B). Figure 1 demonstrates the intrinsic characteristics of a SPF. Both configuration engine and process model portion have hierarchical structures. Each E_i and C_i can be decomposed into more detailed functionalities or processes which will be executed by different employees of different departments. Figure 2 is a more concrete prototype of SPF by adopting original product family designed proposed by [Tseng, 2001], using BPMN process model.

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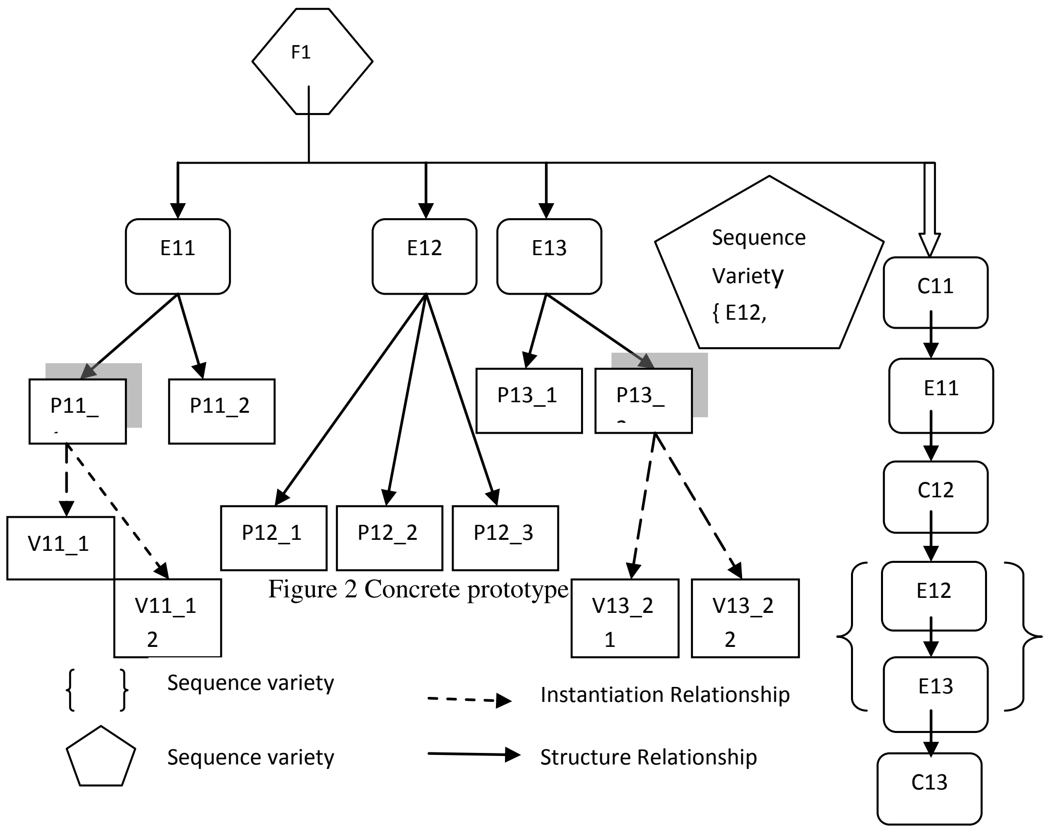

Figure 2 Concrete prototype of SPF

IV. DYNAMIC SERVICE PRODUCT FMAILY

Observing the service industry, for example, telecommunication, travel, hotel, and hospital business, we are not hard to find out that these service providers change their service content every short period of time. For meeting the demands of various groups of customers and following the roadmap of new technology, service providers are force to make changes of their services to be marketing strategy. Therefore, the concept of dynamic service product family (DSPF) comes from the needs of service product family with time variation and these type of changes are called design varieties. In the other respect, process changes derived from prompt customer requests are called runtime varieties due to employee execution. There are many evidences showing that real processes which employees executed are different from what top manage level thinks. Therefore, dynamic service product family is deployed to manage and identify the design variety and runtime variety over time. To discover the design and runtime varieties, process mining techniques are adopt to discover the repetition of pattern of process executed.

A. Design of dynamic service product family

To control the process variety over time, version control, a popular method used in software development, is applied. . Basically, it is a concurrent methodology to manage documents and sources with different purposes. The baseline and branches are maintained for different customers or new development. With version control, a company can easily group different categories of customers by various criteria, such as by country, VIP level and age etc. Based on process mining to realize real processes and version control, we can handle service changes systematically. Figure 3 represents the technology which enables dynamic SPF.

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The criteria of choosing baseline or certain branch are based on the following attributes: (1) permanent or temporary (2) global or local (3) occur frequency (4) reusability. A company can insert more attributes considering its marketing strategy. A permanent, global and reusable variety is suggested to put in the baseline. The occurring frequency of a variety directs the percentage of customer needs.

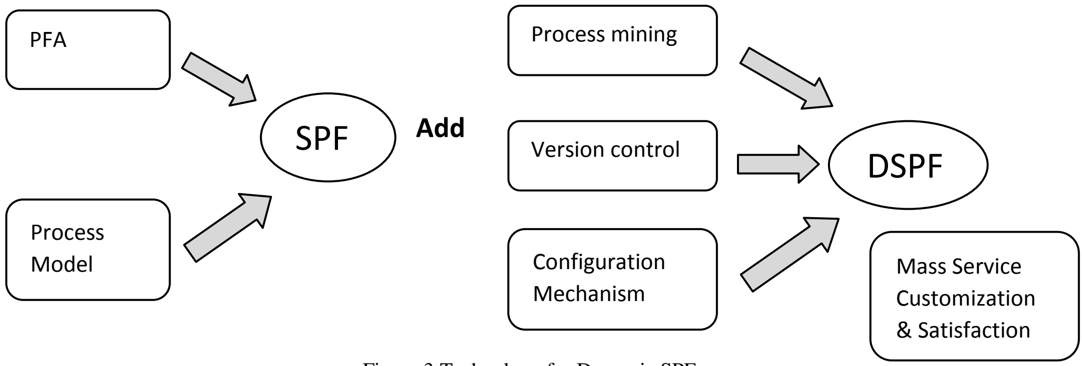

Figure 3 Technology for Dynamic SPF

V. CASE STUDY

In this session, we use a hotel as an example to illustrate the dynamic service product family. We adopt 292 cases which have 2350 event logs in a certain SPF. Figure 4 illustrates the version1.0 honeymoon SPF. Honeymoon package (SPF) is one of the service package the hotel offer to customers. It offers basic bed, dinning and relaxation in this service. Viewing the SPF, customer can easily select different contents of service from the variants of {Ei}s, {Pi}s and {vi}s. For example, a customer can choose content in Honeymoon package of pacific buffee for dinning, body massage for Spa service and biking for relaxation. The process model demonstrated in the SPF is designed by hotel which is the process that customers and employees need to execute. It is in the order of reservation, payment, check-in, bed, dinning, relaxation and check-out. In honeymoon SPF, bed, dinning and relaxation can switch their order based on customers' need. Figure 5 demonstrates design parameters, variants and constraints of honeymoon SPF. Figure 5 also illustrates physical components with defined {Ei} and {Ci} functions.

Figure 6 shows the newly found process model with ProM which is a free process mining tool. By comparing the original defined process model, we discovered several differences. First, for reality, customers only want to pay the deposit instead of overall cost in advanced. And there would be some extra consumption after customer check-in. Hence, it can be seen very clearly in the process, the payment is separated into two parts, before check in and before check out. Otherwise, the customers who choose honeymoon package often required for extra special services like roses, or special dinner in room. Therefore, we discover special requirement in the event logs. This special requirement can be considered customized service candidate in this package. In the other respect, some customer may upgrade the room type, or change room after some consideration. All of this behavior can be found via process mining. After consideration of business strategy, hotel decides to add special requirement and upgrade as customized choice and promote to customer actively as optional. It does create extra benefit for this business. The version 1.1 honeymoon SPF is shown as Figure 7 with constructed version table.

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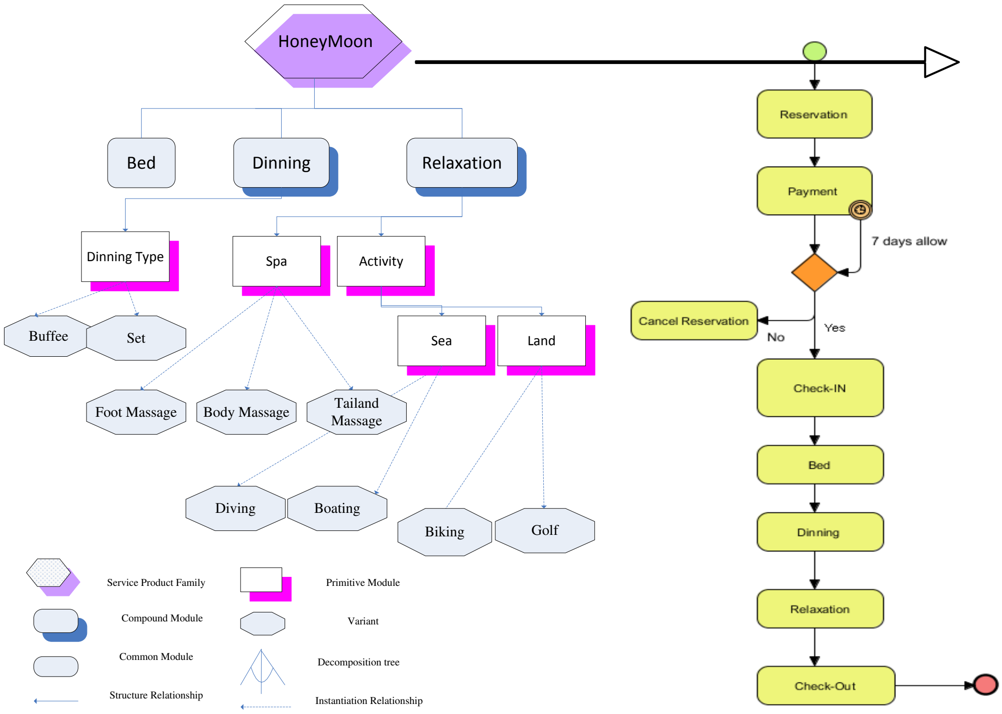

Figure4 Honeymoon SPF

In summary, four aspects of dynamic SPF are introduced; (1) feature based modeling (2) hierarchical structure (3) version control and (4) multiple view of SPF. With feature base modeling, customers could easily communicate with marketing people about their requirements. With hierarchical structure, inner process execution units can extend their varieties and service process into sub-process. With version control, a company can identify different groups of customers as well as service geography with time. We also introduced three views in the SPF, namely functional, behavior, and structure view to facilitate the communication with customers and education of employees as figure 8 shows.

Ⅵ. CONCLUSION

SPF and dynamic SPF are novel concepts in service market. It demonstrates concrete functional requirements as well as execution process flow in a single context. Clear functional requirements and its variants provide clear choice for customers and marketing employees. The execution flow offers employees a standard template to obey. While there are standards, it offers basic quality. In the other respect, SPF and dynamic SPF offer a method to achieve service personalization. It achieves economies of scale by service product family and generates a flexible organization based on generated execution flow in real time. The dynamic SPF especially can provide different service product family versions with time. Besides, SPF can own different versions toward different group of customers.

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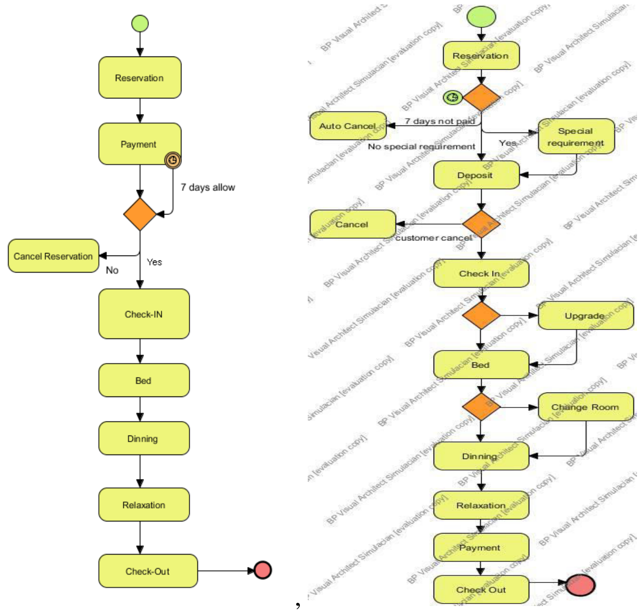
E1 Bed						Module Compound Primitive Compound	Variant
P11 1 Bed				P12 2 Bed			P13 4 Bed
P111 1 King Bed		P112 1 Queen Bed		P121 2 Queen Bed		P122 2 Single Bed	
V1111 Face Sea	V1112 Face Yard	V1121 Face Sea	V1122 Face Yard	V1211 Face Sea	V1212 Face Yard		
E2 Dinning							
P21 Buffee		P22 Set					
V211 Grand Buffee	V212 Pacific Buffee	V221 W Set	V222 C Set				
E3 Relaxation							
P31 Spa				P32 Activity			
P311 Foot Massage	P312 Body Massage		P313 Tailand Massage	P321 Sea		P322 Land	
	V3121 Rose Oil	V3122 Cedarwood Oil		V3211 Boating	V3212 Diving	V3221 Biking	V3222 Golf

Constraints	Input	Constraint
XOR Constraint	2 single bed	No Face Sea
	4 single bed	No face Sea
	below 4 people	No C Set
	No Diving License	Boating
Include Constraint	Honey Moon	Relaxation
	Honey Moon	Dinning
	Family Special	3 people above
Sequence Constraint	Check-in	Pay first
	Check-out	Check-In
	Wedding	After Discussion
	Wedding	After Booking

Figure 5 Design parameters, variants and constraints of Honeymoon SPF



(a) (b)

Figure 6 (a) original defined process model; (b) new process model after process mining

Mass service customization is a new field that still has much to do. The future work of this research can be extended as follows; new process mining methodology will be developed for better SPF module identification. Because different methodology will get different process results, a suitable mining method to dig out the real modules is very important. We are also going to investigate new SPF ontology development method to facilitate the representation of customer required attributes. We hope by doing so, customers can further easily find out their needs. And a company can gain real customer needs more accurately.

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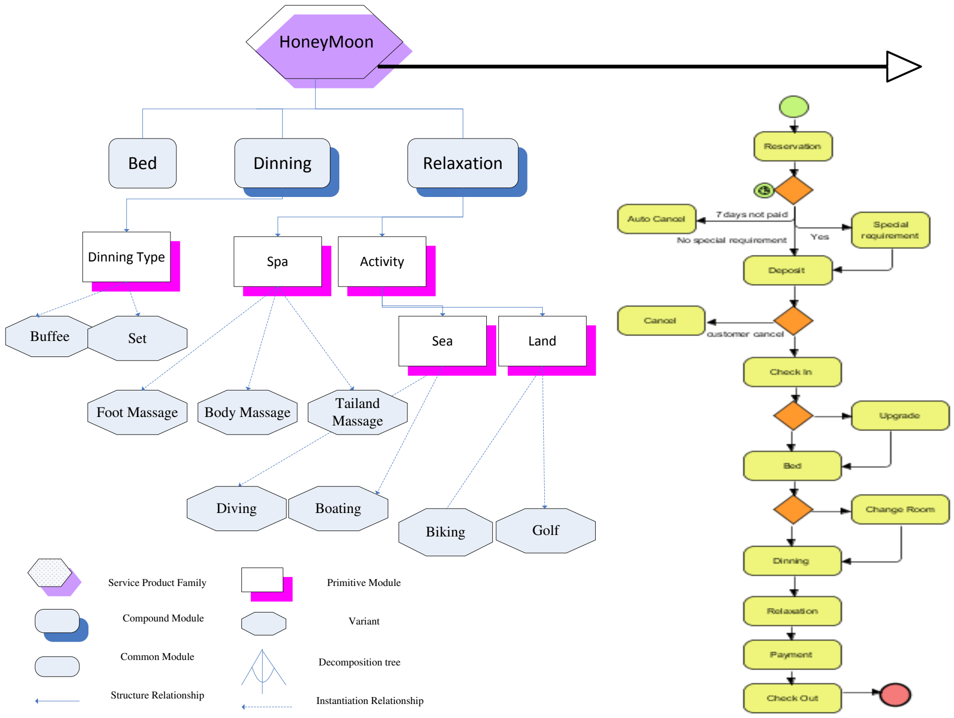

	V1.0	V1.1	Mechanism
Deposit	x	v	insert, replace Payment
special requirement	x	v	insert
payment	v	v	move from before checkin to before checkout
upgrade	x	v	insert
change room	x	v	insert
PC_deposit	x	v	need to do deposit before checkin
PC_special_requirement	x	v	need to order before checkin
PC_change_room	x	v	need to do after bed

Figure 7 V1.1 Honeymoon SPF with version table V1.0_1.1

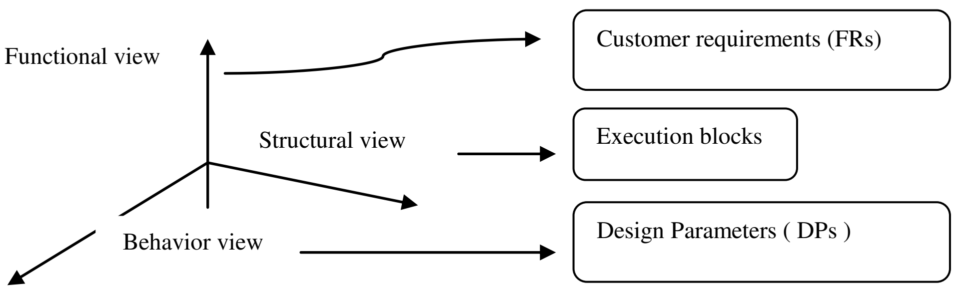

Figure 8 Three View of Service Product Family

REFERENCES

[1] Pine, J. and Gilmore, J., “Welcome to the experience economy”, Harvard Business Review, pp.97-105, 1998
[2]. Du, X., Jiao, J. and Tseng, M. M., “Architecture of Product Family: Fundamentals and Methodology”, Concurrent Engineering: Research and Applications, vol. 9, no. 4, pp. 309-325, 2001

[3] Tseng, M. M and Jiao, J., 1996, “Design for Mass Customization”, Annals of the CIRP, 45/1:153-156

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 2, Issue 11, November 2013

[6] W.M.P. van der Aalst, B.F. van Dongen, J. Herbst, L. Maruster, G. Schimm, A.J.M.M. Weijters, “Workflow mining: a survey of issues and approaches”, Data and Knowledge Engineering, 47 (2) 237-267, 2003

[11] Meyer, M.; Lehnerd, A.P.: “The Power of Product platform ---Bilding Value and Cost leadership”, New York, 1997

[12] Ulrich, K., Eppinger, S.D.: “ Product Design and Development”, “New York, 1995

[15] Fujita, K.; Akagi, S.; Yoneda, T.; Ishikawa, M.:” Simultaneous Optimization of product family sharing system structure and configuration, Design for manufacturing --- DFM’98, Atlanta 1998

[17] Ruth Sara Aguilar-Saven, “Business process modeling: Review and framework”, International Journal of production economics, 2002

[18] Ven der Alast, W.M.P., ter Hofstede, A.H.M. and Weske, M., “Business process management : a survey”, Proceedings of the international Conference on Business Process Management, BPM 2003, Eindhoven, The Netherlands, 26-27 June, 2003

[19] Ryan K.L. Ko; Stephen S.G. Lee; Eng Wah Lee, “Business process management (BPM) standards: a survey”, Busienss process management Journal, Vol. 15, No.5, pp.744-791, 2009

[20] W.M.P van der Alast, J. Desel, A. Oberweis, Models, Techniques, and Empirical Studies, “ Business Process Management”, International Conference on Engineering and Deployment of Cooperative Information Systems, pp.45-63, 2002

[21] W.M.P. van der Alast, A.J. M.M. Weijters, L. Maruster, “ Workflow Mining: Which Processes can be Rediscovered? “Eindhoven University of Techonology, 2002

[22] L. Maruster, A.J.M.M. Weijters, W.M.P van der Aalst, A. van den Bosch, “Process mining: discovering direct successors in process logs, Proceedings of the 5th international Conference on Discovery Science, vol. 2534, Springer-Verlag, Berlin, pp.364-373, 2002

[23] Song, M. and Gunther, C. and van der Aalst, W. “Trace Clustering in Process mining”, Proceedings of the 4th Workshop on Business process intelligence in Conjunction with BPM 2008. Springer, 2008

[24] Christian W. Gunther, Anne Rozinat, W.M.P van der Aalst, “Activity Mining by Global Trace Segmentation”, Springer, lecture notes of business information processing, vol.43, pp.128-139, 2010

[25] R.P. Jagadeesh Chandra Bose, W.M.P van der Aalst, “Abstraction in Process mining: A Taxonomy of patterns”, Springer, lecture notes of computer science, vol. 5701, pp.159-175, 2009

[26] Valarie A. Zeithaml and mary Jo Bitner, “Service Marketing”, McGraw-Hill New York, 1996, p.5

[32] Silveria, G. D., D. Borenstein, et al., “Mass customization: Literature review and research directions.” International journal of production economics **72**(1): 1-13, 2001

[33] Tseng, M. M. and F. T. Piller . “The customer centric enterprise”. In M. Tseng and F. T. Piller (ed.) The customer centric enterprise: advances in mass customization and personalization. Berlin; Hong Kong, Springer, 2003

[34] T. W. Simpson, “Product platform design and customization: status and promise,” Artificial Intelligence for Engineering Design, Analysis and Manufacturing, vol.18, no.1, pp3-20, 2004.

[35] Ulrich, K., “The role of product architecture in the manufacturing firm “, Research Policy, 24(3), pp 419-440, 1995

[36] Jiao, J., Simpson T and Siddique Z, 2006, “Product family design and platform-based product development: A state of the art review”. Journal of Intelligent Manufacturing 18:5–29, 2007

[37] Ma, Qinhai, “An approach to the representation of service process design”, PhD thesis, The Hong Kong University of Science and Technology, 1999

[38] Wikipedia, http://en.wikipedia.org/wiki/List_of_countries_by_GDP_sector_composition

[39] Toussaint, P.J., Bakker, A., Groenewegen, L., “Constructing an enterprise viewpoint: Evaluation of four business modeling techniques”. Computing Methods and Programs in Biomedicine 55(1), 11-30, 1997

[40] Phalp, K., et al., “Quantitative analysis of static models of processes”, Journal of Systems and Software 52 (2) 105-112, 1999

[41] Phalp, K.T., “CAP framework for business process modeling”, Information and Software Technology 142 (5), 371-377, 1998

[42] Macintosh, A.L., “The need for enriched knowledge representation for enterprise”. Artificial intelligence in enterprise modeling, IEEE colloquium on pp. 3/1-3/3, 1993

[43] Workman, J.C., et al. “On the relation between business, business model, software, and ACT-platform architectures”. Information and Technology, 2000